



Washington State Department of Transportation

Vancouver HOV Lane Pilot Project

Evaluation Report #2

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Image Analysis

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Glossary

Auto Occupancy. The number of persons per non-transit vehicle.

Vehicle Occupancy. The number of persons per vehicle, including transit vehicles.

GP Lane: General Purpose Lane. A travel lane that is open to all vehicles.

HOV Lane: High Occupancy Vehicle Lane. A travel lane limited to vehicles carrying more than one person. The I-5 HOV lanes require a minimum of two persons per vehicle. Some HOV lanes require a minimum of three persons per vehicle.

Peak Hour. For this report, the peak hour is defined as the one-hour increment carrying the greatest number of vehicles. The peak hour could also be defined as the one-hour increment carrying the greatest number of persons.

Peak Period. For this report, the peak period is defined as the two-hour increment during which the HOV lane is operational. The peak period is the period of time (1-3 hours typically) with the greatest number of vehicles or the greatest number of persons.

Variable Message Sign (VMS). An electronic sign displaying current travel information. A VMS can display construction status, general traveler information, delays, and safety information.

Vancouver HOV Pilot Project Evaluation Report #2

PURPOSE

This report is the second in a series of evaluation reports that monitor the effectiveness of the Southbound I-5 High Occupancy Vehicle (HOV) Lane Pilot Project that opened to traffic on October 29, 2001. Data was collected by various agencies both before and after the Vancouver HOV lane was implemented. Information contained in this report will compare the March 2002 information to the baseline information (September 2001) contained in the Baseline Report completed by WSDOT and the consultant team. The report also compares the March 2002 post opening data against the November 2001 post opening information.¹ When opened in November, the Vancouver HOV lane hours of operation were 6 to 9 AM. Evaluation Report #1 found Vancouver HOV lane usage to be most heavily concentrated in the first two hours of operation with a drop in usage during the third hour. Based on the usage data, the Vancouver HOV lane hours of operation were reduced by one hour to 6 to 8 AM. The new hours of operation took effect January 14, 2002. The Baseline Report and Evaluation Report #1 were prepared assessing the 6 to 9 AM period. To ensure consistent comparison across reporting periods, the data from those reports was updated to reflect the new 6 to 8 AM operating period.

Figure 1 shows the Vancouver HOV lane corridor as well as traffic count and monitoring locations.

Figure 1. Vancouver HOV Lane and Count/Monitoring Locations



¹ Baseline report data was collected in May and September 2001. Evaluation Report #1 data was collected in November 2001. Evaluation Report #2 data was collected in March 2002.

VANCOUVER HOV LANE GOALS

The goals of the Vancouver HOV Lane Pilot Project are:

1. **Move more people per lane** in the Vancouver HOV lane during the AM peak period **than in either of the adjacent general-purpose lanes**.
2. **Reduce peak period travel time for HOV lane users** and **reduce the average per-person travel time for all users**.
3. **Minimize impacts to other traffic** in the corridor and on parallel facilities.
4. **Increase the use of carpools, vanpools, and transit**.
5. **Maintain safety** by not increasing the accident and incident rate in the corridor during HOV lane operating periods.
6. **Maintain the HOV lane's effectiveness with appropriate enforcement**.
7. **Maintain or improve travel time reliability for carpools, vanpools, and transit**.
8. **Maintain or improve public opinion as to the effectiveness of HOV lanes**.

EVALUATION (PERFORMANCE) MEASURES

An Interagency Team, comprised of representatives from the Washington State Department of Transportation (WSDOT), C-TRAN, the City of Vancouver, Southwest Washington Regional Transportation Council (RTC), Oregon Department of Transportation (ODOT), and Metro, established the following performance measures to be used to evaluate the Vancouver HOV Lane Pilot Project:

Operations – total persons using the corridor, travel times (HOVs, Single Occupant Vehicles [SOVs], and freight), safety, enforcement, traffic impacts to parallel routes, and traffic operations at the beginning and ending transitions.

Modal Impact – HOV lane utilization, transit ridership, increase in transit service, number of persons per vehicle, Park-and-Ride use, vanpool use, and employer programs.

Public Opinion – Public perceptions of success. This will include survey results, phone calls, internet comments, etc.

This report is the second post-HOV opening evaluation report and describes the baseline and post-HOV lane opening conditions for each of the Vancouver HOV lane goals.

DATA COLLECTION METHODOLOGY

Before and after traffic count data were collected from WSDOT, City of Vancouver, RTC, and Clark County. Bus passenger counts were collected by C-TRAN. The consultant team performed travel time runs as well as vehicle occupancy counts using standard and nationally-accepted data collection techniques.

Vehicle occupancy counts consisted of counting every vehicle in a single lane for 15-minute intervals and noting the number of occupants in each vehicle. The occupancy counts rotated across all lanes. Bus ridership was determined using C-TRAN counts provided for those routes using the I-5 corridor on the same dates that vehicle occupancy counts were taken.

Percentages of the number of vehicles and persons for each travel mode were then applied to traffic counts, taken for each lane, by WSDOT's automated traffic recorders that provide continuous traffic counting. Appendix B contains a description of the data collection process for travel time runs.

HOV LANE GOALS

Goal 1. Move more people in the HOV lane during the AM 2-hour period than in either of the adjacent general-purpose lanes.

This measure is the total number of persons traveling the corridor during the AM peak hour or period. **Table 1** shows the total number of person trips (sum of persons per lane) based on counts taken in May 2001 (vehicle occupancies) and September 2001 (counts) for the Baseline Report. Post opening vehicle occupancy and vehicle counts are listed for November 2001 and March 2002. The peak hour is defined as the hour with the highest total volume of vehicles. **Table 2** shows the number of persons per lane, measured near 33rd Street, for the three through traffic lanes in that section. The time period being reported has been changed to 6 to 8 AM to coincide with the change in HOV operating hours.

Table 1 . Total Person Trips Using the I-5 Corridor

Measure	Baseline (September 2001)		After HOV Opening (November 2001)		After HOV Opening (March 2002)	
	Vehicles	Persons	Vehicles	Persons	Vehicles	Persons
Two-hour count (6-8 AM)	6,153	7,010	5,779	7,220	6,100	7,521
Change from baseline	---	---	-374	+210	-53	+511
Percent change from baseline	---	---	-6%	+3%	-1%	+7%
Change from November 2001	---	---	---	---	+321	+301
Percent change from November 2001	---	---	---	---	+6%	+4%
Peak hour count (6:15-7:15 AM)	3,166	3,660	2,984	3,767	3,223	3,981
Change from baseline	---	---	-182	+107	+107	+321
Percent change from baseline	---	---	-6%	+3%	+3%	+9%
Change from November 2001	---	---	---	---	+239	+214
Percent change from November 2001	---	---	---	---	+8%	+6%

Measured near 33rd Street for the three through traffic lanes.

Table 2. Persons Per Lane

Measure	Baseline (September 2001)	After HOV Opening (November 2001)		After HOV Opening (March 2002)	
	All Lanes	HOV Lane	Each GP ¹ Lane	HOV Lane	Each GP Lane
Two-hour count (6-8 AM)	2,337	1,885	2,668	1,888	2,817
Peak hour count (6:15-7:15 AM)	1,220	1,016	1,376	1,003	1,489

Measured near 33rd Street for the three through traffic lanes.

¹ GP Lane = General Purpose Lane

Table 3 shows the average vehicle occupancy (all persons using the corridor divided by the total number of vehicles) and average auto occupancy (person trips in autos divided by the number of autos). Average vehicle occupancy reflects person trips occurring in all modes of travel on I-5. Average auto occupancy is important as it shows the person trips occurring in drive alone, carpool, and vanpool modes and any shift that may occur within auto modes.

Table 3. Average Vehicle Occupancy

Measure	Baseline (September 2001)	After HOV Opening (November 2001)	After HOV Opening (March 2002)	Baseline to November Change	Baseline to March Change	November to March Change
Two-hour average vehicle occupancy	1.14	1.25	1.23	+0.11	+0.09	-0.02
Two-hour occupancy, autos only	1.06	1.16	1.15	+0.10	+0.09	-0.01
Peak hour average vehicle occupancy	1.16	1.26	1.24	+0.10	+0.08	-0.02
Peak hour occupancy, autos only	1.06	1.16	1.14	+0.10	+0.08	-0.02

Based on measurements taken near 33rd Street.

Auto occupancy is persons in passenger autos divided by the number of autos.

Vehicle occupancy is total persons in all vehicles (including transit).

Findings To Date

- The number of peak period persons on I-5 has increased compared to both the prior to HOV opening and to the first “after opening” report.
- The number of peak hour persons using the I-5 corridor has increased compared to both the prior to HOV opening and the first report after opening.
- During both the November 2001 and March 2002 evaluation periods, the Vancouver HOV lane was not carrying more persons per lane than either of the adjacent general purpose lanes.
- There is an increase in the average auto and average vehicle occupancies on I-5 compared to the Baseline (prior to HOV opening).
- Average auto and average vehicle occupancies declined slightly from November to March.

The tables above are summaries of vehicle occupancy counts, traffic counts, and bus ridership counts taken before and after the Vancouver HOV lane opened. The tables in Appendix A give baseline and “post-opening” total number of persons carried in the corridor and mode shares as well as comparing the average auto and vehicle occupancies to the baseline data. The tables in the Appendix provide more detailed summaries of the vehicle occupancies, mode shares, and vehicle and person trip usage in the I-5 corridor.

Goal 2. Reduce peak period travel time for HOV lane users and reduce the average per-person travel time for all users.

Travel time will be measured by taking travel time runs in the field and making comparisons between the HOV and GP lanes.

Travel times are summarized for single-occupancy vehicles and high occupancy vehicles in **Tables 4 and 5**. Since there was no HOV lane in the baseline condition, it is assumed that all of the vehicles on southbound I-5 had the same travel time. Travel time by segment has been averaged over multiple observations made in September 2001 during the 6 to 8 AM period using the moving vehicle method described in the appendix of this report. The travel times were categorized for vehicles traveling on the corridor between the 134th Street interchange and the Interstate Bridge. Travel times were measured between off ramps. Note that travel time computations are based on a limited number of observations and are subject to considerable variation. The listed travel times are approximate values, not absolute numbers.

**Table 4. Two-Hour Travel Time Results for HOV and General Purpose Users
99th Street to Interstate Bridge (Average, 6-8 AM)**
Travel Time in Minutes per Vehicle

		Travel Time: 99 th Street to Interstate Bridge (mid-point)			
		Travel Time	Change Baseline to November	Change Baseline to March	Change November to March
Baseline Travel Time – All Users		9.9	---	---	---
Travel Time After HOV Opening – November '01	GP ¹ Lanes	9.1	-0.8	---	---
	HOV Lane	7.1	-2.8	---	---
Travel Time After HOV Opening – March '02	GP Lanes	11.3	---	+1.4	+2.2
	HOV Lane	6.4	---	-3.5	-0.7

Travel time runs over three different days in September 2001, four different days in November-December 2001, and three different days in March 2002.

¹ GP = General Purpose

Findings To Date

- The Vancouver HOV lane saves users an average of 3 minutes per HOV vehicle over the entire two-hour period compared to GP users. This is approximately one minute per mile.
- Between November and March, higher GP lane volumes over the two-hour period have resulted in an increase in GP travel time over the entire two-hour period of approximately 2 minutes.

A more detailed travel time summary is included in Appendix A.

**Table 5. Peak Hour Travel Time Results for HOV and General Purpose Users
99th Street to Interstate Bridge (Average, 6:15-7:15 AM)**

Travel Time in Minutes per Vehicle

		Travel Time: 99 th Street to Interstate Bridge (mid-point)			
		Travel Time	Change Baseline to November	Change Baseline to March	Change November to March
Baseline Travel Time – All Users		7.9	---	---	---
Travel Time After HOV Opening – November '01	GP ¹ Lanes	8.3	+0.4	---	---
	HOV Lane	7.6	-0.3	---	---
Travel Time After HOV Opening – March '02	GP Lanes	11.5	---	+3.6	+3.2
	HOV Lane	6.3	---	-1.6	-1.3

Travel time runs over three different days in September 2001, four different days in November-December 2001, and three different days in March 2002.

¹ GP = General Purpose

Findings To Date

- Travel time savings during the peak hour for users of the Vancouver HOV lane have increased since the November reporting period. Travel time savings measured in November averaged slightly less than 1 minute per HOV vehicle compared to GP users. Travel time savings from November to March averaged between 5 and 6 minutes per HOV vehicle.
- GP users have experienced an increase in travel time of approximately 3 minutes during the peak hour commute from November to March.

Tables 22 and 23 detail C-TRAN bus travel times in the corridor.

A more detailed travel time summary is included in Appendix A.

The second half of Goal 2 is to reduce the average per person travel time for all users. Per person travel time is measured by summing the travel times for all persons in the HOV lane and the general purpose lanes and dividing the total travel time by the total number of persons. **Tables 6 and 7** summarize travel time per person. Since there was no HOV lane in the baseline condition, it is assumed that all of the vehicles on southbound I-5 had the same travel time. Page 6 contains a detailed summary of the methodology used to calculate average travel times.

Table 6. Two-Hour Per Person Travel Time – 99th Street to Interstate Bridge
(Average, 6:00-8:00 AM)
 Travel Time in Minutes per Person

		6 – 8 AM Travel Time ¹	Total Persons	Total Travel Time	Travel Time per Person
Baseline travel time – all users		9.9	7,010	69,399	9.9
Travel time after HOV opening – November '01	GP ² lanes	9.1	5,335	48,549	8.6
	HOV lane	7.1	1,885	13,384	
Travel time after HOV opening – March '02	GP lanes	11.3	5,633	63,653	10.1
	HOV lane	6.4	1,888	12,083	

¹ Vehicle travel time: 99th Street to Interstate Bridge (mid-point)

² GP = General Purpose Lane

Findings To Date

- Travel time per person has increased compared to both the Baseline and the November reporting periods. HOV travel times have decreased but GP lane travel times have increased.

Table 7. One-Hour Per Person Travel Time – 99th Street to Interstate Bridge
(Average, 6:15-7:15 AM)
 Travel Time in Minutes per Person

		6:15–7:15 AM Travel Time ¹	Total Persons	Total Travel Time	Travel Time per Person
Baseline travel time – all users		7.9	3,660	28,914	7.9
Travel time after HOV opening – November '01	GP ² lanes	8.3	2,751	22,833	8.1
	HOV lane	7.6	1,016	7,722	
Travel time after HOV opening – March '02	GP lanes	11.6	2,761	32,028	10.1
	HOV lane	6.3	1,047	6,596	

¹ Vehicle travel time: 99th Street to Interstate Bridge (mid-point)

² GP = General Purpose Lane

Findings To Date

- Travel time per person in the November reporting period decreased compared to the Baseline, while travel time per person increased for the March reporting periods. HOV travel times have decreased GP lane travel times have increased.

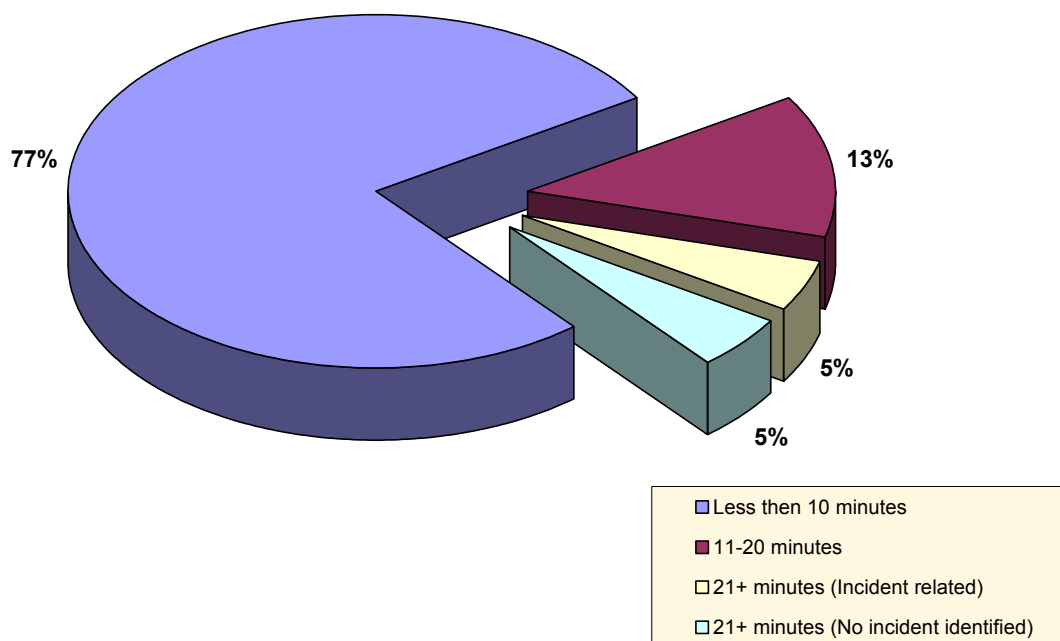
WSDOT Incident Response Vehicle Travel Times

WSDOT also provides an incident response vehicle that drives and monitors the I-5 corridor during peak periods to respond to incidents or motorists' maintenance needs on the corridor. WSDOT has been collecting travel times from those vehicle runs. The travel times are from the 99th Street Interchange to the Interstate Bridge. These runs are summarized in **Figure 2**. This information corroborates the general purpose travel times summarized in **Tables 4 and 5**.

The data collected during WSDOT's travel time runs has been utilized on a daily basis to provide "real time" information to the traveling public. The travel time information is posted on WSDOT's VMS southbound on I-5 near the Clark County Fairgrounds. The figure summarizes incident vehicle trip times between 6:00 and 8:00 during which the WSDOT vehicle did not stop to assist a motorist. The chart summarizes 184 trips between December 17, 2001 and April 9, 2002. For trips in excess of 20 minutes, the figure denotes whether the delay was related to an incident. Nine (9) of the 18 trips over 20 minutes were incident related.

The average travel time for the 184 trips was 10.3 minutes. If the 9 incident trips over 20 minutes are removed, the average travel time for the remaining 175 trips was 9.0 minutes.

Figure 2: I-5 SB General Purpose Lane Travel Time Distribution



Goal 3. Minimize impacts to other traffic in the corridor and on parallel facilities.

With increased delay in the general-purpose lanes, there is a potential that traffic could divert to parallel routes, such as I-205, Highway 99, and Hazel Dell Avenue. Additionally, before and after counts were taken for Main Street south of I-5 and for Lakeshore Drive south of 99th Street to determine if traffic was diverting onto those facilities.

The share of traffic on each facility at the screenline at 99th Street is summarized in **Table 8**. **Tables 9** and **10** summarize before and after counts for Main Street and Lakeshore Drive.

This goal will be measured by taking before and after counts on Highway 99, Hazel Dell Avenue, and I-205.

Table 8. Facility Shares of North-South Traffic

Measure	I-5 Share (percent)	I-205 Share (percent)	Others Share* (percent)	Total Vehicles
Two-hour period baseline share (September 2001)	37%	55%	8%	16,998
Two-hour period share, after HOV opening (November 2001)	36%	54%	10%	17,390
Two-hour period share, after HOV opening (March 2002)	37%	56%	7%	17,050
Share change, baseline to November 2001	-1%	-1%	+2%	+392
Share change, baseline to March 2002	0%	+1%	-1%	+52
Share change, November 2001 to March 2002	+1%	+2%	-3%	-340

I-5 and "Others" measured at 99th Street. I-205 measured at Mill Plain Boulevard.

**"Others" include Highway 99 and Hazel Dell Avenue.

Findings To Date

- The Vancouver HOV Lane has not caused a significant shift to parallel routes.

Table 9. Traffic Counts Near 33rd Street

Measure	I-5 Count	Main Street Count*	I-5 Share (percent)	Main St. Share (percent)
Two-hour period baseline average count* (September 2001)	6,153	489	93%	7%
Two-hour period average count, after HOV opening (November 2001)	5,779	785	88%	12%
Change, baseline to November 2001	-374	+296	---	---
Two-hour period average count, after HOV opening (March 2002)	6,100	835	88%	12%
Change, baseline to March 2002	-53	+346	---	---
Change, November 2001 to March 2002	+321	+50	---	---

Measured near 33rd Street (on I-5) and south of 39th Street (Main Street).

*Main Street southbound off ramp from I-5 was closed in the Baseline count period.

Findings To Date

- I-5 two-hour period traffic decreased 1% in March compared to the Baseline.
- I-5 two-hour period traffic increased 6% in March compared to November.
- Some I-5 traffic shifted onto Main Street after the off-ramp was reopened in October.
- Some of the Main Street traffic is likely headed to downtown Vancouver.

During the 5-9 a.m. period, I-5 is carrying more vehicles compared to the Baseline and November reporting periods. I-5 traffic count data from the 5-6 a.m. and 8-9 a.m. period were analyzed to determine if traffic volumes were shifting to the hour before or after HOV lane operating hours. There is no evidence to conclude that the HOV lane is causing a shift of traffic to the 5-6 a.m. period or the 8-9 a.m. period. See **Table A-12** in Appendix A for detailed I-5 traffic counts.

Table 10. Lakeshore Traffic Counts

Measure	Lakeshore Count
Two-hour period baseline count (May 2001)	742
Two-hour period count, after HOV opening (November 2001)	892
Two-hour period count, after HOV opening (March 2002)	850
Change, baseline to November 2001	+150
Percent Change, baseline to November 2001	+20%
Change, baseline to March 2002	+108
Percent Change, baseline to March 2002	+15%
Change, November 2001 to March 2002	-42
Percent Change, November 2001 to March 2002	-5%

Measured south of 99th Street.

Findings To Date

- Traffic on Lakeshore increased 15% in March compared to the Baseline.
- Traffic on Lakeshore decreased 5% in March compared to November.
- The I-5 counts south of 99th Street in November and March both slightly increased from the baseline.
- There is no evidence to conclude that the HOV lane is causing a diversion of traffic onto Lakeshore Avenue.

Goal 4. Increase the use of carpools, vanpools, and transit.

This goal will be measured by vehicle counts and data from C-TRAN on ridership and Park-and-Ride utilization.

Persons in Carpools, Vanpools, and Transit

Table 11 shows the persons in carpools, vanpools, and transit before and after HOV opening. The after HOV opening persons are reported for I-5 users regardless of which lane they are using.

Table 11. Two-Hour Persons in Carpools, Vanpools, and Transit on I-5

Mode	Baseline Persons	After HOV Opening (November 2001)		After HOV Opening (March 2002)	
		All Through Lanes	HOV Lane Only	All Through Lanes	HOV Lane Only
Carpools and Vanpools	738	1,905	1,252	1,695	1,294
Transit	490	555	555	553	553
TOTAL	1,228	2,460	1,807	2,248	1,847

Baseline is from September 2001.

After HOV Opening is from November 2001 and March 2002.

Findings To Date

- There has been an increase in the average auto and average vehicle occupancies on I-5 compared to the Baseline.
- There has been an increase in the number of persons using I-5 in carpools, vanpools, and transit. Excluding eligible HOVs that are using the general purpose lanes, the Vancouver HOV lane has led to an increase of over 600 persons in carpools, vanpools, and transit compared to the baseline. HOV lane demand increased by approximately 2% compared to November 2001.
- Transit usage has remained steady since November 2001, possibly reflecting the I-5 commuter buses being at capacity.
- Vehicle volumes have decreased slightly while the number of persons in carpools and vanpools has increased significantly.

Park-and-Ride Usage

Park-and-Ride usage can be used to measure the performance of the Vancouver HOV lane. Changes in Park-and-Ride usage can be compared to changes in transit ridership to identify any patterns of increased or decreased transit usage. Park-and-Ride usage is summarized in **Table 12**.

Table 12. Park-and-Ride Usage

Location	Baseline Daily Usage (Vehicles)	Daily Usage after HOV Opening (November 2001)	Daily Usage After HOV Opening (March 2002)
Salmon Creek Park-and-Ride	439*	438*	428*
Klineline Park	15	22	22

May 15-17, 2001 average (baseline).

November 2001 and March 2002 (post-opening).

*Salmon Creek Park-and-Ride is operating at capacity.

Vanpools and Employer Programs

C-TRAN offers a vanpool service program. C-TRAN subsidizes 25 percent of the lease cost for vanpools traveling to or from Clark County. C-TRAN also subsidizes the entire cost of fuel for vanpools traveling to or from Clark County and provides car wash coupons free of charge to vanpools participants. Eight (8) commuter vanpools carrying 86 vanpool riders currently operate. All 8 vanpools carry passengers from Washington to Oregon. Those vanpools travel to Farmers Insurance, Tektronics, and Fred Meyers.

The number of vanpools has not changed since the November reporting period. The number of vanpools currently operating is significantly less than past years. In February 2000, 15 vanpools were operating from Clark County to the Portland area. C-TRAN staff believes the decline in vanpools is attributable to the slowing economy and associated job decreases.

Findings To Date

- The Salmon Creek Park-and-Ride continues to operate at capacity, limiting growth in transit use of the HOV lane.
- The number of vanpools has not changed since the opening of the HOV lane.

Goal 5. Maintain safety by not increasing the accident and incident rate in the corridor during HOV lane operating periods.

Safety is measured by examining reported accidents before and after HOV lane opening. There is a time lag between the time of the accident and when the accident is recorded to the state's accident database. Therefore, all reported accidents might not be included in this report.

A secondary measure is also used to evaluate corridor safety, which consists of using Washington State Police (WSP) and WSDOT incident management vehicle callout logs. As needed, the WSP dispatches incident response requests to WSDOT through their traffic management center. WSDOT staff is available to respond to provide assistance to disabled vehicles, crash scenes, and other incidents. The number of callouts is a measure of safety. The Washington State Patrol (WSP) and WSDOT provided a detailed list of all reported collisions and call-outs on the southbound side of I-5 between 134th Street and the Interstate Bridge from 6 to 9 AM for the month of September (**Table 13**) and the month of November (**Table 14**). **Table 15** details the number of WSP and WSDOT call-outs on the southbound side of I-5 between 134th Street and the Interstate Bridge from 6 to 9 AM for a three week period in March. This correlates the number of callouts for incident management, accident scene traffic control, etc. with the safety information needed to evaluate the project.

A word of caution to the reader: accident statistics tend to lag behind the actual reporting dates and accidents often go unreported. Additionally, accident studies tend to look at multiple year periods of at least three years rather than short-term periods such as this. Caution is expressed about drawing long-term conclusions from short-term data.

Table 13. Baseline Three-Hour Incident Management Call-Outs

WSP Call-Outs	WSDOT Incident Response Vehicle Call-Outs
<u>On Roadway Incidents</u> 4 property damage collisions 3 blocking disabled vehicles 2 traffic hazard reports	<u>On Roadway Incidents</u> 1 property damage collision
<u>Off-Roadway Incidents</u> 2 abandoned non-blocking vehicles 1 disabled non-blocking vehicle	<u>Off-Roadway Incidents</u> 0 Off-Roadway incidents

September 2001 data (I-5 SB 6 to 9 AM).

Table 14. November 2001 Post Opening Three-Hour Incident Management Call-Outs

WSP Call-Outs	WSDOT Incident Response Vehicle Call-Outs
<u>On Roadway Incidents</u> 5 property damage collisions 7 blocking disabled vehicles 0 traffic hazard reports	<u>On Roadway Incidents</u> 0 property damage collisions
<u>Off-Roadway Incidents</u> 0 abandoned non-blocking vehicles 0 disabled non-blocking vehicles	<u>Off-Roadway Incidents</u> 0 Off-Roadway incidents

October 29 - November 16, 2001 data (I-5 SB 6 to 9 AM)

Table 15. March 2002 Post Opening Three-Hour Incident Management Call-Outs

WSP Call-Outs	WSDOT Incident Response Vehicle Call-Outs
<u><i>On Roadway Incidents</i></u> 2 property damage collisions 3 blocking disabled vehicles 0 traffic hazard reports	<u><i>On Roadway Incidents</i></u> 1 property damage collision 1 blocking disabled vehicle
<u><i>Off-Roadway Incidents</i></u> 2 abandoned non-blocking vehicles 4 disabled non-blocking vehicles	<u><i>Off-Roadway Incidents</i></u> 1 Off-Roadway incident

March 11 – March 29, 2002 data (I-5 SB 6 to 9 AM).

Findings To Date

- Operation of the Vancouver HOV lane appears to have had no impact on corridor safety or the number of incidents. The actual number of reported collisions has decreased between November and March.

Goal 6. Maintain the HOV lane's effectiveness at 15% violation rate or less.

A measure of the HOV's effectiveness is to examine its violation rate. This is measured in two ways: the number of observed violators using the auto occupancy counts taken for the Vancouver HOV lane, and results of enforcement activities.

Tables 16 through 19 show the vehicle shares by auto occupancies and travel modes using the Vancouver HOV lane during the HOV operating periods. The drive alone share in the HOV lane represents those who were observed violating the HOV restriction. Note that motorcycles are eligible HOV lane vehicles regardless of the number of occupants.

Table 16. November 2001 Two-Hour HOV Lane Observed Violation Rates
Using Vehicle Occupancy Counts

Mode	Percent of Total Vehicles
Drive alone	5%
Eligible Vehicles	95%
TOTAL	100%
<i>OBSERVED VIOLATION RATE</i>	5%

Calculations shown include spreadsheet rounding. Average of occupancy counts taken November 13 and 14, 2001.

Table 17. November 2001 Peak Hour HOV Lane
Observed Violation Rates
Using Vehicle Occupancy Counts

Mode	Percent of Total Vehicles
Drive alone	5%
Eligible vehicles	95%
TOTAL	100%
<i>OBSERVED VIOLATION RATE</i>	5%

Calculations shown include spreadsheet rounding. Average of occupancy counts taken November 13 and 14, 2001.

Table 18. March 2002 Two-Hour HOV Lane
Observed Violation Rates
Using Vehicle Occupancy Counts

Mode	Percent of Total Vehicles
Drive alone	5%
Eligible Vehicles	95%
TOTAL	100%
<i>OBSERVED VIOLATION RATE</i>	5%

Calculations shown include spreadsheet rounding. Average of occupancy counts taken March 20 and 21, 2002.

**Table 19. March 2002 Peak Hour HOV Lane
Observed Violation Rates**
Using Vehicle Occupancy Counts

Mode	Percent of Total Vehicles
Drive alone	4%
Eligible vehicles	96%
TOTAL	100%
<i>OBSERVED VIOLATION RATE</i>	4%

Calculations shown include spreadsheet rounding. Average of occupancy counts taken March 20 and 21, 2001.

The November 2001 and March 2002 peak period violation rates were 5 percent. The peak hour violation rate decreased 1% in March compared to November. The national violation rate average is in the 10-15% range. The Portland HOV lane has a violation rate of 10%, which is also within the national guidelines. The Vancouver lane has a violation rate of 5%, which is well within acceptable guidelines.

Enforcement

Another measure of the performance of the Vancouver HOV lane is to track the number of HOV citations and warnings issued over time. For baseline conditions, the HOV lane was not operational; therefore, there were no HOV lane violations. The number and frequency of HOV lane violations after HOV lane opening are reported in **Table 20**.

Table 20. Enforcement Data

Category	November 2001 Weekly Average	November 2001 Daily Average	March 2002 Weekly Average	March 2002 Daily Average	Weekly % Change Nov to March	Daily % Change Nov to March
HOV citations	7	1	12	3	71%	200%
HOV warnings	25	5	6	1	-76%	-80%
Seat belt violations	4	1	2	1	-50%	0%
No insurance	8	2	1	0	-88%	-100%
Tows	2	1	0	0	-100%	-100%
# Car officers	9	1.9	9	1.9	0%	0%
# M/C officers	12	2.5	6	1.2	-50%	-52%
# Enforcement hours	11	2.3	9	1.9	-18%	-17%

The weekly average number of citations and warnings issued decreased by 44% from November to March. The rate of warnings issued has dropped significantly while the number of citations issued has increased. The enforcement data confirm the low violation rate in the Vancouver HOV lane. Had the violation rate been higher, the number of warnings and citations would have been higher as well.

Goal 7. Maintain or improve HOV travel time reliability in the corridor.

HOV travel time reliability is measured by determining if the Vancouver HOV lane is maintaining an average speed of 45 mph or higher over the length of the lane. Additionally, on-time bus performance statistics will be evaluated. **Table 21** details average travel speeds for the HOV lane.

Table 21. HOV Average Travel Speeds
Over Two-Hour Period and Peak Hour

Time	November '01 Average Speed (MPH)	March '02 Average Speed (MPH)
Two-hour period 6-8 AM		
99 th Street to SR-500	62	62
SR-500 to Mill Plain	55	56
<i>Average over Length of HOV Lane</i>	60	60
Peak hour 6:15-7:15 AM		
99 th Street to SR-500	62	63
SR-500 to Mill Plain	55	46
<i>Average over Length of HOV Lane</i>	60	58

Measured from 99th Street to Mill Plain Boulevard.

Travel Time Runs from November-December 2001 and March 2002.

Findings To Date

- The Vancouver HOV lane is maintaining at least 45 mph along its entire length both during peak hours and overall during the two-hour period.

Bus on-time performance statistics include measuring the travel time from the Salmon Creek Park-and-Ride to the Interstate Bridge. **Tables 22** and **23** provide detailed summaries of the travel times for C-TRAN Route 34 from the Salmon Creek Park-and-Ride facility to the Interstate Bridge.

Table 22. Two-Hour Travel Time Results for C-TRAN Buses from Salmon Creek to Interstate Bridge (Average 6-8 AM)

Travel Time in Minutes per Bus

	Travel Time: Salmon Creek Park-and-Ride to Interstate Bridge			
	Travel Time	Change Baseline to December	Change Baseline to March	Change December to March
Baseline Travel Time	14.1	---	---	---
Travel Time After HOV Opening – Report #1	11.9	-2.2	---	---
Travel Time After HOV Opening – Report #2	11.6	---	-2.5	-0.3

Travel time runs over two days in October 2001, three days in December 2001, and three days in March 2002. Travel times for C-TRAN Route 134 from Salmon Creek Park-and-Ride to Interstate Bridge.

Findings to Date

- Travel time savings during the Two-Hour Period for C-TRAN Route 134 have increased since the Baseline reporting period and the December reporting period.

Table 23. Peak Hour Travel Time Results for C-TRAN Buses from Salmon Creek to Interstate Bridge (Average 6:15-7:15 AM)

Travel Time in Minutes per Bus

	Travel Time: Salmon Creek Park-and-Ride to Interstate Bridge			
	Travel Time	Change Baseline to December	Change Baseline to March	Change December to March
Baseline Travel Time	12.9	---	---	---
Travel Time After HOV Opening – Report #1	9.6	-3.3	---	---
Travel Time After HOV Opening – Report #2	10.5	---	-2.4	+0.9

Travel time runs over two days in October 2001, three days in December 2001, and three days in March 2002. Travel times for C-TRAN Route 134 from Salmon Creek Park-and-Ride to Interstate Bridge.

Findings to Date

- Travel time savings during the Peak Hour for C-TRAN Route 134 have increased since the Baseline reporting period.
- Travel time savings during the Peak Hour for C-TRAN Route 134 decreased from the December reporting period to the March reporting period.

Goal 8. Maintain or improve public opinion as to the effectiveness of HOV lanes.

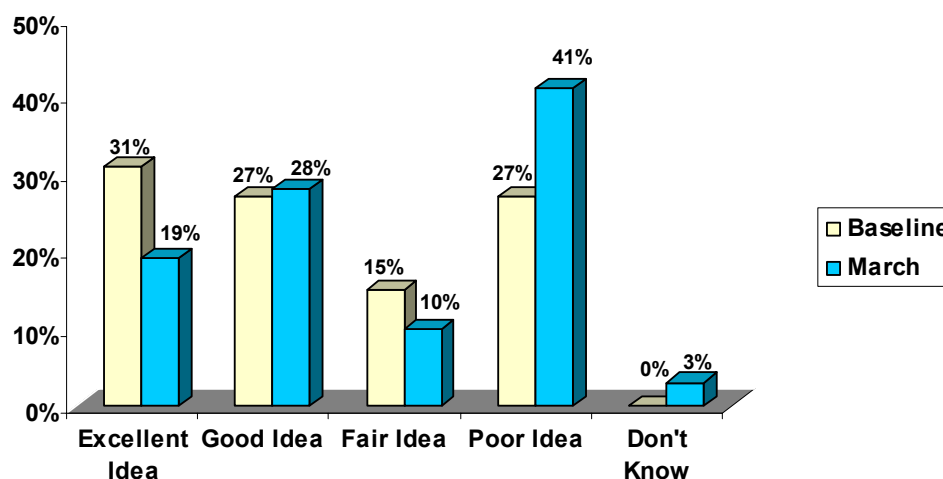
Surveys will be conducted once before and twice during the pilot project. Three public opinion evaluation reports will be generated through the life of the evaluation period.

PUBLIC OPINION SURVEY

Public opinion surveys will be taken to gauge public opinion about the Vancouver HOV lane and HOV lanes in general before and during the Pilot Project. The first survey was commissioned in September 2001 Baseline. The second survey was commissioned in March 2002. Approximately 200 households were surveyed with a margin of error of $\pm 7\%$. The following conclusions were drawn from the second survey:

- Opinions regarding the Vancouver HOV lane remained strong. Forty-seven percent (47%) of the respondents surveyed agree that the Vancouver HOV lane is an excellent or good idea as compared to 58% of respondents completing the Baseline study in September 2001. The majority of this change stems from a decrease of individuals rating the Vancouver HOV lane as an excellent idea from the Baseline to the March survey. At the same time, the number of respondents asserting that the HOV lane is a poor idea increased 14% from 27% in the baseline to 41% in the March survey.

Do you think the Vancouver HOV lane is an...

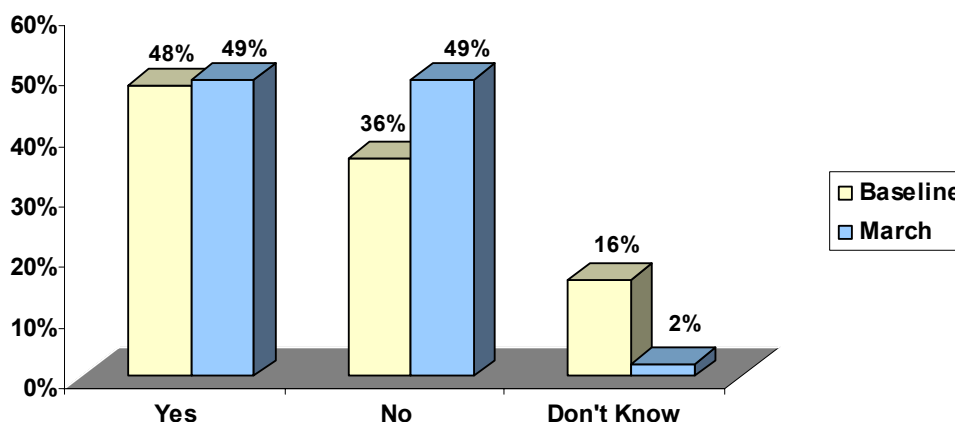


- The Vancouver HOV lane appears to have had an impact on travel behavior. Twenty-seven percent (27%) of respondents indicated that their driving habits have changed since the inception of the HOV lane. Of these 54 respondents, 33% cited a change of route or travel pattern, 19% now carpool, 17% leave earlier or later for their destination, 6% made changes in their work schedules and 4% take the bus. The Washington State residents represented here assert that they have made these changes since the lane opening. Of the 19% that declared they now carpool, 30% of them stated that they carpool at least 2 days a week or more earlier in the survey.
- In terms of the amount of time for the typical morning commute since the Vancouver HOV lane trial period started, 40% of respondents testify to a slower commute, 16% conclude their commutes are faster, and 44% believe the commute to be the same length. Fifty-five percent (55%) of respondents in Battleground expressed the drive is

slower, which is statistically significant to the 27% in Vancouver. This is most likely because 53% of Battleground respondents exit after Mill Plain Boulevard and consequently have a longer commute, although 51% of Vancouver respondents also exit after Mill Plain. Among carpoolers who travel together two days or more per week, forty three percent (43%) cite a faster drive since the inception of the HOV lane while 18% believe the trip to be longer.

- The majority of respondents, 77%, agreed that the time change in lane hours from 6 - 9 AM to 6 - 8 AM made no difference in their commute time. Keep in mind, however, that all respondents in the March survey generally travel between 6 and 8 AM and, thus, a change from 9 AM to 8 AM would not affect them.
- Fifty-four percent (54%) of the respondents interviewed feel that changes are needed to the Vancouver HOV lane. The most recommended change, expressed by 68% of those suggesting changes, is to eliminate the HOV lane entirely. Nineteen percent (19%) suggest adding a new lane or extending the current lane, and 18% advise a change in hours or time of use.
- Most of those surveyed have now formed an opinion about whether or not to make the Vancouver HOV lane permanent. The community members surveyed are split nearly 50/50 regarding permanent lane adoption. Forty-nine percent (49%) support permanent lane adoption and 49% oppose such an idea. The percentage of respondents in support of the Vancouver lane adoption differs by only 1% compared to the Baseline study results of 48%. However, unlike the Baseline, the March survey had only 2% of respondents stating an uncertainty about lane adoption, compared to 16% who were unsure in the baseline. It seems that the trial period has helped to solidify public opinion and has it split evenly down the middle.

Do you think the Vancouver HOV lane should be permanently adopted?



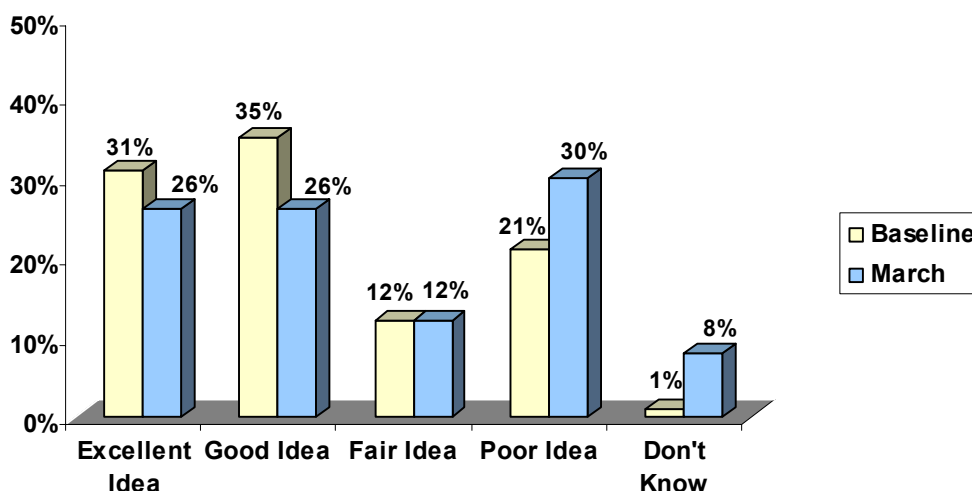
- The reasons most often cited for support of the permanent adoption of the Vancouver HOV lane were:

Encourages carpooling/benefits carpoolers	34%
Get there faster/save time	24%
Traffic moves better/faster	15%
Works well, good idea	13%

- The reasons most often cited for opposition to the permanent adoption of the Vancouver HOV lane were:

Would cause more delays/worsen the problem	32%
Not used enough/waste capacity of lane	19%
Gets abused, not used properly	12%
HOV is not effective, it doesn't work	11%
- Fifty-two percent (52%) of the respondents surveyed think the Portland HOV lane is an excellent or good idea compared to sixty-six percent (66%) of the respondents in the Baseline survey. Forty-two percent (42%) of the respondents surveyed think the Portland HOV lane is a fair or poor idea compared to thirty-four percent (34%) in the Baseline survey. The number of respondents that are uncertain about the Portland HOV lane increased from less than one percent (1%) in the Baseline survey to approximately eight percent (8%) in the March survey.

Do you think the Portland HOV lane is an...



The following commuter statistics were drawn from the survey:

- The majority of respondents, 45%, enter I-5 southbound at/or south of the 99th Street interchange, as opposed to 38% who enter the same stretch of road from the north. The March survey had 8% more respondents entering at/or south of the 99th Street interchange than in the Baseline.
- Exactly half of the respondents exit I-5 southbound south of Mill Plain Boulevard and nearly 30% suggested their exit patterns vary by their daily commute. The data showed that 23% of respondents exit before or at Mill Plain Boulevard.
- Ninety-three percent (93%) of the respondents interviewed primarily drive or carpool to their destinations most often as compared to 96% from the baseline. Vancouver respondents have the lowest percentage of respondents that drive or carpool, 86%, although 8% of respondents ride C-TRAN or Tri-Met. The fact that 97% of Battleground respondents drive or carpool compared to 87% of Vancouver commuters who drive or

carpool is statistically significant. This means that proportionally, the percentage of respondents in Battleground that drive or carpool is significant to the percentage coming from Vancouver.

- Of the population surveyed, 5% use C-TRAN either from a Park & Ride or other means, and 1% ride Tri-Met most often. As in the Baseline, the majority of respondents, 72%, commuting via mass transportation came from the Vancouver zip-code cluster.
- The average length of time a traveler reports commuting to work, school, shopping, or other activities, one-way, is 29.05 minutes. This is roughly 4 ½ minutes longer than the commuting results found in the Baseline study. The longest commute is for respondents coming from Battleground at 40 minutes (compared to 33.8 minutes in the Baseline), while north Clark County has the second lengthiest commute of 30 minutes.
- Sixty-eight percent (68%) of the respondents typically drive alone, up 7% from the Baseline and only 10% usually drive or ride with someone else. The percentage of commuters driving or riding with someone else fell 15% from the Baseline study. Interestingly, the number of travelers both driving alone and driving or riding with someone else increased from 10% in the Baseline to 17% in the March study.

COMMENTS RECEIVED FROM EMAILS, LETTERS, AND PHONE CALLS

Agencies within Clark County have received phone calls, letters, and e-mails regarding the Vancouver HOV lane. Most were sent to WSDOT with some directed to RTC and others to C-TRAN. Comments generally were received from those stating they used I-5 as a regular commute, while other comments were received from elected officials and others with interest in the project. Some of the comments were received through the "Hot Issues" section of the web site of the local newspaper, The Columbian.

WSDOT is recording these comments for consideration during the HOV evaluation process.

Several comments were received regarding the length of the commute after HOV opening; WSDOT directed the consultant team to collect additional travel time data to respond to these concerns. Additionally, comments received resulted in modifications to how data is being presented in this report; namely, the data is summarized for both the two-hour HOV operating period and for the peak hour.

KEY FINDINGS AND CONCLUSIONS TO DATE

- Of the eight HOV goals, the Vancouver HOV pilot project is meeting five goals and partially meeting two goals. The pilot project is meeting Goals 3, 4, 5, 6, and 7. The pilot project is partially meeting goals 2 and 8. Goal 1 is not being met.
1. Move more people per lane in the HOV lane during the AM peak period than in either of the adjacent general-purpose lanes.
 - The Vancouver HOV lane is not currently carrying more people per lane than either of the adjacent lanes.
 2. Reduce peak period travel time for HOV lane users and reduce the average per-person travel time for all users.
 - Peak period travel times for HOV lane users are being reduced. Average per-person travel times for all users are not being reduced.
 3. Minimize impacts to other traffic in the corridor and on parallel facilities.
 - The share of traffic on I-205 has increased slightly while the share of traffic on Highway 99 and Hazel Dell Avenue has decreased. The share of traffic on Main Street has increased. Part of this increase may be attributable to the full opening of I-5/Main Street interchange. Traffic on Lakeshore has also increased.
 4. Increase the use of carpools, vanpools, and transit.
 - The number of carpools and transit ridership have increased. Transit ridership increased initially and remained stable from November to March, possibly reflecting that C-TRAN's I-5 Park-and-Ride lots and commuter buses are at capacity.
 5. Maintain safety by not increasing the accident and incident rate in the corridor during HOV lane operating periods.
 - The number of accidents and incidents has not increased since the HOV became operational.
 6. Maintain the HOV lane's effectiveness with appropriate enforcement.
 - WSP regularly patrols the Vancouver HOV lane. The weekly average number of citations and warnings issued decreased by 44% from November to March. The enforcement data confirm the low violation rate in the HOV lane. Had the violation rate been higher, the number of warnings and citations likely would have been higher as well.
 7. Maintain or improve travel time reliability for carpools, vanpools, and transit.
 - Peak period travel times for carpools, vanpools, and transit users are being reduced.
 8. Maintain or improve public opinion as to the effectiveness of HOV lanes.
 - Public opinion is being assessed as part of the evaluation process. Forty-seven percent (47%) of the respondents surveyed agree that the Vancouver HOV lane is an excellent or good idea. The number of respondents asserting that the HOV lane is a poor idea is 41%. Most respondents have formed opinions about

whether or not to make the Vancouver HOV lane permanent. Forty-nine percent (49%) support permanent lane adoption and 49% oppose the idea.

- There were 642 total HOV vehicles in the Vancouver HOV lane during the two-hour period, and 348 during the peak hour. The Vancouver HOV lane is carrying 26 percent of the person trips in 11 percent of the vehicles on I-5 during the two-hour period. During the peak hour, the Vancouver HOV lane is carrying 27 percent of the person trips on I-5 in 12 percent of the vehicles. At this time, the Vancouver HOV lane is not carrying more persons per lane than either of the adjacent general purpose lanes.
- The Vancouver HOV lane has contributed to an increase in the average auto and average vehicle occupancies on I-5. The Vancouver HOV lane has increased the number of persons using I-5 in carpools, vanpools, and transit.
- The Vancouver HOV Lane has a violation rate of 5%, which is well within acceptable guidelines.
- The Vancouver lane is maintaining at least 45 mph along its entire length both during peak hours and overall during the two-hour period.
- Bus ridership on I-5 routes has increased from 490 two-hour period riders before the HOV lane opened to 553 two-hour period riders after the HOV lane opened.
- During the two-hour period, HOV saves users an average of three minutes per HOV vehicle over the entire two-hour period. This is approximately one minute per mile. Higher GP lane volumes over the two-hour period have resulted in an increase in GP travel time over the entire two-hour period of approximately two minutes.
- Travel time savings for users of the Vancouver HOV lane have increased since the November reporting period. Travel time savings measured in November averaged two minutes per HOV vehicle compared to GP users. Travel time savings from November to March averaged almost five minutes per HOV vehicle. GP users have experienced a decrease of more than two minutes during the peak hour commute from November to March.
- Opinions regarding the Vancouver HOV lane remain strong. Forty-seven percent (47%) of the respondents surveyed agree that the Vancouver HOV lane is an excellent or good idea as compared to 58% of respondents completing the baseline study in September 2001. The majority of this change stems from a decrease of individuals rating the HOV lane as an excellent idea from the baseline to the March survey. At the same time, the number of respondents asserting that the HOV lane is a poor idea increased from 27% in the Baseline to 41% in the March survey.
- Most respondents have now formed an opinion about whether or not to make the HOV lane permanent. Forty-nine percent (49%) support permanent lane adoption and 49% oppose the idea. The percentage of respondents in support of HOV lane adoption differs by only 1% compared to the Baseline study results of 48%. However, unlike the Baseline, the March survey had only 2% of respondents stating an uncertainty about lane adoption, compared to 16% who were unsure in the Baseline.
- Operation of the Vancouver HOV lane appears to have had no impact on corridor safety or the number of incidents. The actual number of reported collisions has decreased between November and March.

APPENDIX A

Tables A-1 through **A-10** give baseline and “post-opening” total number of persons carried in the corridor and mode shares as well as comparing the average auto and vehicle occupancies to the baseline data. These tables provide detailed summaries of the vehicle occupancies, mode shares, and vehicle and person trip usage in the I-5 corridor. The data from these tables were used to develop **Tables 1** through **3** in the main document.

Tables A-1 and **A-6**, respectively, summarize the baseline two-hour and peak hour person-trip mode shares for all three through traffic lanes while **Tables A-2, A-3, A-7, and A-8** summarize the two-hour and peak hour person-trip mode shares for the November and March post-opening reporting periods. **Tables A-4** and **A-5** are for the HOV and GP lanes for the two-hour period, while **Tables A-9** and **A-10** are peak hour tables summarizing the HOV and two through general purpose traffic lanes.

**Table A-1. Baseline Two-Hour Persons by Mode
for all Lanes on Southbound I-5**
Measured Near 33rd Street

Mode	6 to 8 AM Number of Vehicles	Total Persons	Percent of Total Persons
Drive alone	5,288	5,288	76%
Carpool: 2-person	316	632	9%
Carpool: 3+ person	31	93	>1%
Trucks	498	498	7%
Motorcycles	0	0	0%
Buses	20	499	7%
TOTAL	6,153	7,010	100%

*Note: Rounding may result in a sum of the percentages being less than or greater than 100%.

Occupancy counts (each mode's share of total traffic) taken May 16 and 17, 2001.

Traffic counts taken in September 2001.

Bus data obtained from C-TRAN.

Average vehicle occupancy = total number of persons/total number of vehicles
 Average vehicle occupancy = $7,010/6,153 = 1.14$
 Average auto occupancy = total number of non-transit persons/total number of non-transit vehicles
 Average auto occupancy = $6,511/6,133 = 1.06$

**Table A-2. November 2001 Post Opening Two-Hour Persons
by Mode for all Lanes on Southbound I-5**

Measured Near 33rd Street

Mode	6 to 8 AM Number of Vehicles	Total Persons	Percent of Total Persons
Drive alone	4,570	4,570	63%
Carpool: 2-person	780	1,560	22%
Carpool: 3+ person	23	69	1%
Vanpools	8	88	1%
Trucks	378	378	5%
Motorcycles	0	0	0%
Buses	20	555	8%
TOTAL	5,779	7,220	100%

*Note: Rounding may result in a sum of the percentages being less than or greater than 100%.

Occupancy counts (each mode's share of total traffic) and traffic counts taken in November 2001.

Bus data obtained from C-TRAN.

Average vehicle occupancy = total number of persons/total number of vehicles
 Average vehicle occupancy = $7,220/5,779 = 1.25$
 Average auto occupancy = total number of non-transit persons/total number of non-transit vehicles
 Average auto occupancy = $6,665/5,759 = 1.16$

**Table A-3. March 2002 Post Opening Two-Hour Persons
by Mode for all Lanes on Southbound I-5**

Measured Near 33rd Street

Mode	6 to 8 AM Number of Vehicles	Total Persons	Percent of Total Persons
Drive alone	4,999	4,999	66%
Carpool: 2-person	790	1,580	21%
Carpool: 3+ person	9	27	<1%
Vanpools	8	88	1%
Trucks	264	264	4%
Motorcycles	10	10	<1%
Buses	20	553	7%
TOTAL	6,100	7,521	100%

*Note: Rounding may result in a sum of the percentages being less than or greater than 100%.

Occupancy counts (each mode's share of total traffic) and traffic counts taken in March 2002.

Bus data obtained from C-TRAN.

Average vehicle occupancy = total number of persons/total number of vehicles
 Average vehicle occupancy = $7,521/6,100 = 1.23$

Average auto occupancy = total number of non-transit persons/total number of non-transit vehicles

Average auto occupancy = 6,968/6,080 = 1.15

Table A-4. November 2001 Post Opening Two-Hour Persons by Mode for Southbound I-5: HOV and GP Lanes
Measured Near 33rd Street

Mode	HOV Lane			GP Lanes		
	6 to 8 AM Number of Vehicles	Total Persons	Percent of Total Persons	6 to 8 AM Number of Vehicles	Total Persons	Percent of Total Persons
Drive alone	31	31	2%	4,539	4,539	85%
Carpool: 2-person	571	1,142	61%	209	418	8%
Carpool: 3+ person	23	69	4%	0	0	0%
Vanpools	8	88	5%	0	0	0%
Trucks	0	0	0%	378	318	7%
Motorcycles	0	0	0%	0	0	0%
Buses	20	555	30%	0	0	0%
TOTAL	653	1,885	100%	5,126	5,335	100%

*Note: Rounding may result in a sum of the percentages being less than or greater than 100%.

Average of occupancy counts taken November 13 and 14, 2001.

Bus data obtained from C-TRAN.

Table A-5. March 2002 Post Opening Two-Hour Persons by Mode for Southbound I-5: HOV and GP Lanes
Measured Near 33rd Street

Mode	HOV Lane			GP Lanes		
	6 to 8 AM Number of Vehicles	Total Persons	Percent of Total Persons	6 to 8 AM Number of Vehicles	Total Persons	Percent of Total Persons
Drive alone	31	31	2%	4,968	4,968	88%
Carpool: 2-person	612	1,224	65%	178	356	6%
Carpool: 3+ person	5	15	1%	4	12	<1%
Vanpools	5	55	3%	3	33	1%
Trucks	0	0	0%	264	264	5%
Motorcycles	10	10	<1%	0	0	0%
Buses	20	553	29%	0	0	0%
TOTAL	683	1,888	100%	5,417	5,633	100%

*Note: Rounding may result in a sum of the percentages being less than or greater than 100%.

Average of occupancy counts taken March 20 and 21, 2002.

Bus data obtained from C-TRAN.

Table A-6. Baseline Peak Hour Persons by Mode for all Southbound I-5 Lanes
Measured Near 33rd Street

Mode	6:15 to 7:15 AM Number of Vehicles	Total Persons	Percent of Total Persons
Drive alone	2,708	2,708	74%
Carpool: 2-person	150	300	8%
Carpool: 3+ person	16	48	>1%
Trucks	278	278	8%
Motorcycles	0	0	0%
Buses	14	326	9%
TOTAL	3,166	3,660	100%

*Note: Rounding may result in a sum of the percentages being less than or greater than 100%.

Occupancy counts (each mode's share of total traffic) taken May 16 and 17, 2001.

Traffic counts taken in September 2001.

Bus data obtained from C-TRAN.

Average vehicle occupancy = total number of persons/total number of vehicles
 Average vehicle occupancy = $3,660/3,166 = 1.16$
 Average auto occupancy = total number of non-transit persons/total number of non-transit vehicles
 Average auto occupancy = $3,334/3,152 = 1.06$

Table A-7. November 2001 Post Opening Peak Hour Persons by Mode for all Southbound I-5 Lanes
Measured Near 33rd Street

Mode	6:15 to 7:15 AM Number of Vehicles	Total Persons	Percent of Total Persons
Drive alone	2,356	2,356	63%
Carpool: 2-person	403	806	21%
Carpool: 3+ person	12	36	1%
Vanpools	4	44	1%
Trucks	195	195	5%
Motorcycles	0	0	0%
Buses	14	330	9%
TOTAL	2,984	3,767	100%

*Note: Rounding may result in a sum of the percentages being less than or greater than 100%.

Occupancy counts (each mode's share of total traffic) and traffic counts taken in November 2001.

Bus data obtained from C-TRAN.

Average vehicle occupancy = total number of persons/total number of vehicles
 Average vehicle occupancy = $3,767/2,984 = 1.26$
 Average auto occupancy = total number of non-transit persons/total number of non-transit vehicles

$$\text{Average auto occupancy} = 3,473/2,970 = 1.16$$

**Table A-8. March 2002 Post Opening Peak Hour Persons by Mode
for all Southbound I-5 Lanes**

Measured Near 33rd Street

Mode	6:15 to 7:15 AM Number of Vehicles	Total Persons	Percent of Total Persons
Drive alone	2,647	2,647	66%
Carpool: 2-person	406	812	20%
Carpool: 3+ person	8	24	1%
Vanpools	4	44	1%
Trucks	140	140	4%
Motorcycles	4	4	<1%
Buses	14	310	8%
TOTAL	3,223	3,981	100%

*Note: Rounding may result in a sum of the percentages being less than or greater than 100%.

Occupancy counts (each mode's share of total traffic) and traffic counts taken in March 2002.

Bus data obtained from C-TRAN.

$$\begin{aligned} \text{Average vehicle occupancy} &= \text{total number of persons/total number of vehicles} \\ \text{Average vehicle occupancy} &= 3,981/3,223 = 1.24 \\ \text{Average auto occupancy} &= \text{total number of non-transit persons/total number of} \\ &\quad \text{non-transit vehicles} \\ \text{Average auto occupancy} &= 3,671/3,209 = 1.14 \end{aligned}$$

**Table A-9. November 2001 Post Opening Peak Hour Persons by Mode
for Southbound I-5: HOV and GP Lanes**

Measured Near 33rd Street

Mode	HOV Lane			GP Lanes		
	6:15 to 7:15 AM Number of Vehicles	Total Persons	Percent of Total Persons	6:15 to 7:15 AM Number of Vehicles	Total Persons	Percent of Total Persons
Drive alone	16	16	2%	2,340	2,340	85%
Carpool: 2-person	295	590	58%	108	216	8%
Carpool: 3+ person	12	36	4%	0	0	0%
Vanpools	4	44	4%	0	0	0%
Trucks	0	0	0%	195	195	7%
Motorcycles	0	0	0%	0	0	0%
Buses	14	330	32%	0	0	0%
TOTAL	341	1,016	100%	2,643	2,751	100%

*Note: Rounding may result in a sum of the percentages being less than or greater than 100%.

Average of occupancy counts taken November 13 and 14, 2001.

Bus data obtained from C-TRAN.

**Table A-10. March 2002 Post Opening Peak Hour Persons by Mode
for Southbound I-5: HOV and GP Lanes**
Measured Near 33rd Street

Mode	HOV Lane			GP Lanes		
	6:15 to 7:15 AM Number of Vehicles	Total Persons	Percent of Total Persons	6:15 to 7:15 AM Number of Vehicles	Total Persons	Percent of Total Persons
Drive alone	13	13	1%	2,634	2,634	88%
Carpool: 2-person	310	620	62%	96	192	6%
Carpool: 3+ person	4	12	1%	4	12	<1%
Vanpools	4	44	4%	0	0	0%
Trucks	0	0	0%	140	140	5%
Motorcycles	4	4	<1%	0	0	0%
Buses	14	310	31%	0	0	0%
TOTAL	349	1,003	100%	2,874	2,978	100%

*Note: Rounding may result in a sum of the percentages being less than or greater than 100%.

Average of occupancy counts taken March 20 and 21, 2002.

Bus data obtained from C-TRAN.

Findings To Date

- Although the number of two-hour vehicles has decreased, the number of two-hour person trips carried on the I-5 corridor has increased compared to the baseline.
- The number of total HOV vehicles has increased during the two hours of HOV operation and during the peak hour of operation.
- Bus ridership on I-5 routes has increased from 499 two-hour-period riders before the Vancouver HOV lane opened to 553 two-hour period riders after the Vancouver HOV lane opened in March. This ridership level is steady since November 2001, possibly reflecting that C-TRAN's I-5 Park-and-Ride lots and commuter buses are at capacity.
- During the two-hour period, the Vancouver HOV lane is carrying 25 percent of the person trips in 11 percent of the vehicles on I-5. During the peak hour, the Vancouver HOV lane is carrying 27 percent of the person trips on I-5 in 12 percent of the vehicles.

Table A-11 provides a detailed summary of I-5 traffic counts near Jantzen Beach for the 6:00 – 8:00 a.m. period.

Table A-11. Traffic Volumes for all Lanes on Southbound I-5

Measured Near Jantzen Beach

Time Period	Baseline (September 2001)	After HOV Opening (November 2001)	After HOV Opening (March 2002)
6:00-7:00 a.m.	4,166	4,113	4,284
7:00-8:00 a.m.	4,124	4,103	4,313
Total	8,290	8,216	8,597

Traffic counts taken in September 2001, November 2001, and March 2002.

Table A-12 provides a detailed summary of southbound I-5 traffic counts for the 5:00 – 9:00 a.m. period.

Table A-12. Traffic Volumes for all Lanes on Southbound I-5

Measured Near 33rd Street

Time Period	Baseline (September 2001)	After HOV Opening (November 2001)	After HOV Opening (March 2002)
5:00-6:00 a.m.	1,599	1,733	1,615
6:00-7:00 a.m.	3,036	2,934	3,072
7:00-8:00 a.m.	3,117	2,845	3,028
8:00-9:00 a.m.	2,837	3,073	3,071
Total	10,589	10,585	10,786

Traffic counts taken in September 2001, November 2001, and March 2002.

Tables A-13 and A-14 provide detailed travel time summary data. The data from these tables were used to develop **Tables 4 and 5** in the main document.

**Table A-13. Two-Hour Travel Time Results for HOV and General Purpose Users
99th Street to Interstate Bridge (Average, 6-8 AM)**

Travel Time in Minutes per Vehicle

		I-5 Segment			
		99 th Street to SR-500	SR-500 to Mill Plain	Mill Plain to Interstate Bridge (mid-point)	TOTAL
Baseline travel time – all users		4.6	1.8	3.5	9.9
Travel time after HOV opening – November '01	GP ¹ Lanes	3.8	2.5	2.8	9.1
	HOV Lane	3.3	1.2	2.6	7.1
Travel time after HOV opening – March '02	GP Lanes	5.0	3.5	2.8	11.3
	HOV Lane	3.3	1.2	1.9	6.4
Travel time change between baseline and November '01	GP Lanes	-0.8	+0.7	-0.7	-0.8
	HOV Lane	-1.3	-0.6	-0.9	-2.8
	HOV Travel Time Compared to GP Lanes ²	-0.5	-1.3	-0.2	-2.0
Travel time change between baseline and March '02	GP Lanes	+0.4	+1.7	-0.7	+1.4
	HOV Lane	-1.3	-0.6	-1.6	-3.5
	HOV Travel Time Compared to GP Lanes	-1.7	-2.3	-0.9	-4.9
Travel time change between November '01 and March '02	GP Lanes	+1.2	+1.0	0.0	+2.2
	HOV Lane	0.0	0.0	-0.7	-0.7
	HOV Travel Time Compared to GP Lanes	-1.2	-1.0	-0.7	-2.9

Travel time runs over three days in September 2001, four days in November-December 2001, and three days in March 2002.

¹ GP = General Purpose

² A negative number indicates a reduction in travel time.

**Table A-14. Peak Hour Travel Time Results for HOV and General Purpose Users
99th Street to Interstate Bridge (Average, 6:15-7:15 AM)**

Travel Time in Minutes per Vehicle

		I-5 Segment			
		99 th Street to SR-500	SR-500 to Mill Plain	Mill Plain to Interstate Bridge (mid-point)	TOTAL
Baseline travel time – all users		4.1	1.1	2.7	7.9
Travel time after HOV opening – November '01	GP¹ lanes	3.5	2.1	2.7	8.3
	HOV lane	3.3	1.2	3.1	7.6
Travel time after HOV opening – March '02	GP lanes	4.8	4.8	1.9	11.5
	HOV lane	3.2	1.5	1.6	6.3
Travel time change between baseline and November '01	GP lanes	-0.6	+1.0	0	+0.4
	HOV lane	-0.8	+0.1	+0.4	-0.3
	HOV travel time compared to GP lanes²	-0.2	-0.9	+0.4	-0.7
Travel time change between baseline and March '02	GP lanes	+0.7	+3.7	-0.7	+3.6
	HOV lane	-0.9	+0.4	-1.1	-1.6
	HOV travel time compared to GP lanes	-1.6	-3.2	-0.4	-5.2
Travel time change between November '01 and March '02	GP lanes	+1.3	+2.7	-0.7	+3.2
	HOV lane	-0.1	+0.3	-1.5	-1.3
	HOV travel time compared to GP lanes	-1.4	-2.4	-0.8	-4.5

Travel time runs over three days in September 2001, four days in November-December 2001, and three days in March 2002.

¹ GP = General Purpose

² A negative number indicates a reduction in travel time.

APPENDIX B

Travel Time Methodology

The following is the methodology used for conducting travel time studies of the corridor. These were used to establish baseline conditions and will be used for the evaluation data collection.

1. Travel time runs begin at approximately 6 AM and end at approximately 9 AM.
2. If there is an incident such as bad weather, construction, maintenance, or an accident that affects traffic, note it and continue the study. Note the weather, date, day of week, and time of the run. It is desirable that this be done at the beginning of each run.
3. Try to travel at the median speed. As necessary, pass slow moving vehicles and allow fast moving vehicles to pass, but try to make sure that an equal number of vehicles pass as are passed.
4. At each checkpoint, note the time. If the location gets cut off it can be deduced from the previous location by its order. If the time gets cut off and it cannot be figured out, the run will need to be repeated another day.